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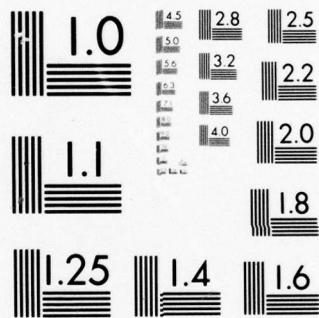
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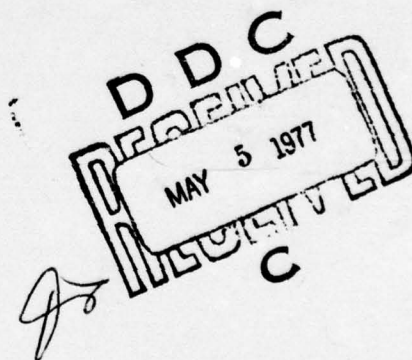
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AMMRC CTR 77-10

TWELFTH ANNUAL REPORT OF THE
MACHINABILITY DATA CENTER

FEBRUARY 1977

JOHN F. KAHLES and JOHN L. KREBS
Metcut Research Associates Inc.
Cincinnati, Ohio



TWELFTH ANNUAL - CONTRACT DSA 900-75-C-2071

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Prepared for

ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

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→ During the period of this report, 4,044 copies of MDC publications were sold. This number includes 2,263 copies of the 2nd Edition of the *Machining Data Handbook*, 1,203 copies of the newly issued publications and 578 copies of MDC publications developed under prior DoD contracts. Additionally, 9 computer programs and 11 programmable calculator strips pertaining to the economics of machining were sold.

A total of 292 inquiries were processed during this report period with emphasis on machining of high temperature alloys and nontraditional machining methods.

MDC's seminar program "Practical Machining Principles for Shop Application" continued to be a highly successful means of disseminating machining information. This program attracted 630 attendees from government and industry, bringing the totals for 39 seminars to 1,188 attendees from 589 companies located in 40 states. The seminars will be continued during the next contract period.



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SUMMARY

The Machinability Data Center (MDC) is one of a number of Information Analysis Centers sponsored by the Department of Defense. The specific functions of MDC include the collection, evaluation, storage, and dissemination of information pertaining to all phases of machining technology. The objectives of MDC's efforts are to decrease the cost of machining and to increase the productivity and reliability of machined products in behalf of the Department of Defense and other U.S. Government Agencies and their contractors. MDC services are also available to private industry because of the continuing need for the universal application of machining data.

This is the Twelfth Annual Report covering the activities of the Machinability Data Center during the 17-month period from August 1, 1975, to December 31, 1976. MDC became operational in October 1964.

MDC is gratified with the response to its various machinability data and information dissemination programs. The current methods employed by MDC for information transfer include the technical inquiry services program, the production and distribution of current publications covering machining data on new materials and new machining methods, and the highly successful seminar program.

During this reporting period, a total of 292 inquiries were processed by MDC. A total of 4,044 publications were sold which includes 2,263 copies of the *Machining Data Handbook*. Included in the publications sold are three new pamphlets: *Machining (A Process Checklist)*, *Nontraditional Machining Guide*, and *Group Technology*.

A total of 19 seminars were conducted during this reporting period. These seminars were attended by 630 individuals representing all phases of manufacturing management, engineering, and shop operations in private industry and Government. The seminar program has been so successful and so well received that the Machinability Data Center will continue this program into calendar year 1977. Six seminar sessions are planned for the spring of 1977 and six more sessions for the fall.

Income from MDC's programs during this reporting period resulted in a 74% cost recovery compared to the contractual requirements of 65% for the period.

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PREFACE

The Twelfth Annual Report of the Machinability Data Center (MDC) covers work performed under Contract DSA900-75-C-2071 from August 1, 1975, to December 31, 1976. The termination date of this contract was extended by amendment P00004 from July 31, 1976, to September 30, 1976, and further extended by amendment P00005 to December 31, 1976.

MDC is operated by Metcut Research Associates Inc., 3980 Rosslyn Drive, Cincinnati, Ohio 45209. The MDC program is administered by the Defense Logistics Agency. Technical supervision is provided by the Army Materials and Mechanics Research Center, Watertown, Massachusetts.

The report was released by Dr. John F. Kahles, Director of the Machinability Data Center, in February 1977.

The Machinability Data Center wishes to acknowledge the significant contributions of the following individuals who have assisted MDC in carrying out this program:

Joseph L. Blue - DLA
Michael C. Corridore - DLA
Samuel Valencia - AMMRC
Frances Burke - DESC
Dolores H. Braun - DESC
Cincinnati Office - DCASMA

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INTRODUCTION

The Machinability Data Center (MDC) is one of a number of Information Analysis Centers sponsored by the Department of Defense. MDC is operated by Metcut Research Associates Inc., 3980 Rosslyn Drive, Cincinnati, Ohio 45209, under contract to the Defense Logistics Agency, Contract No. DSA900-75-C-2071, with technical monitoring by the Army Materials and Mechanics Research Center, Arsenal Street, Watertown, Massachusetts. The contract is issued by the Defense Electronics Supply Center, Dayton, Ohio, and administered by the Commander, DCASMA Cincinnati, Federal Office Bldg., 550 Main Street, Cincinnati, Ohio 45202.

The Machinability Data Center has been in continuous operation since 1964 and until 1972 operated as the Air Force Machinability Data Center under contract to the Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio.

SCOPE

The Machinability Data Center collects, evaluates, stores and disseminates material removal information including specific and detailed machining data for the Department of Defense, other Government Agencies, their contractors and subcontractors, and to private industry in a manner that will not interfere with the required Government support. MDC's operation emphasizes engineering evaluation for the purpose of developing material removal parameters, such as speed, feed, depth of cut, tool material and geometry, cutting fluids and other significant variables which comprise a machining situation. Data is being processed for all types of materials and for all kinds of material removal operations, both traditional and nontraditional.

MDC has a hard-copy document file of over 30,000 selected and evaluated documents pertaining to material removal technology. This file has a supporting computerized index which permits immediate retrieval of selected documents pertaining to a specific material with definite chemical, physical, and mechanical properties and a specific material removal operation.

SERVICES

Services provided by MDC are designed to assist its Users in Government and private industry by increasing productivity and reducing costs in all phases relating to the machining technology areas of manufacturing technology.

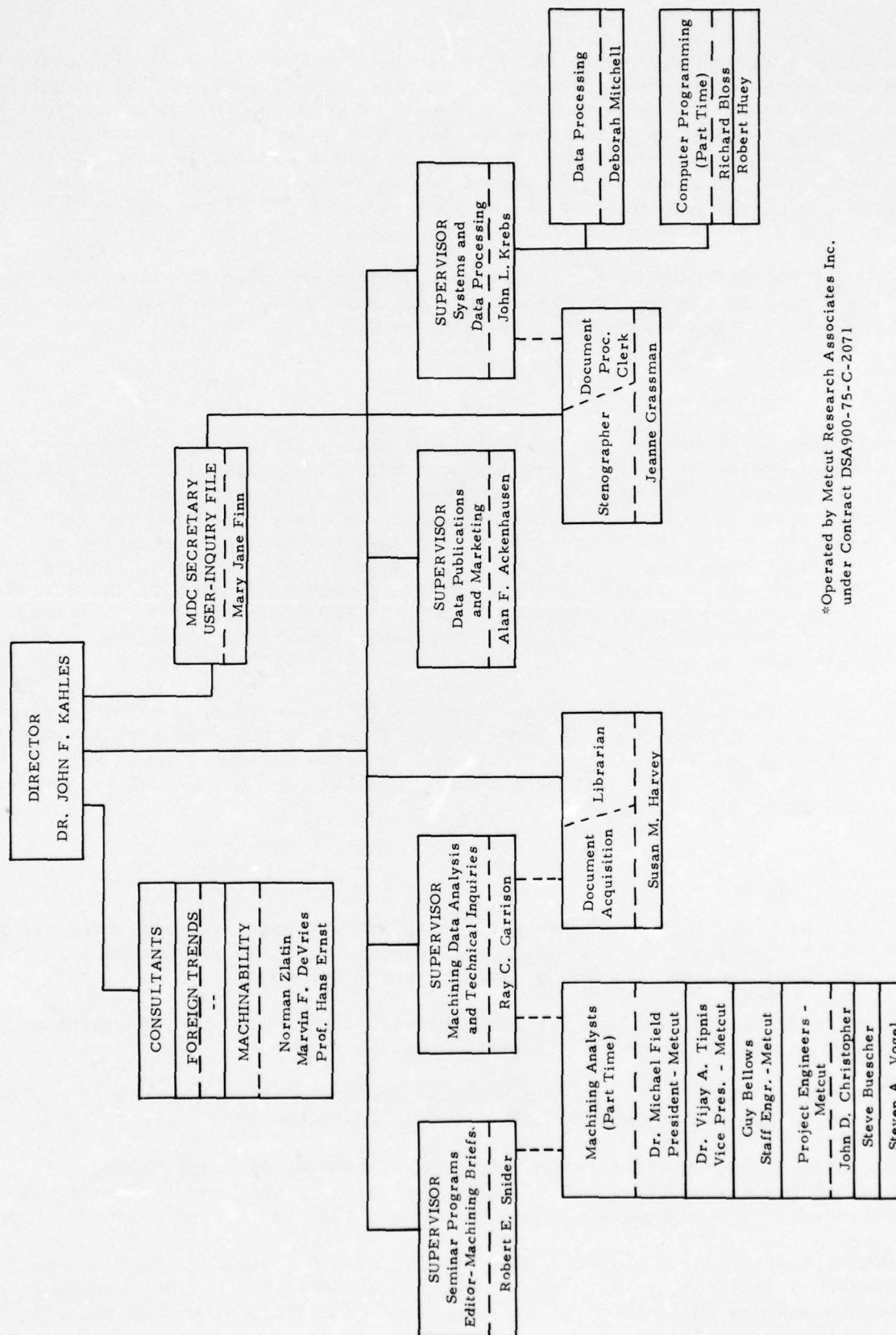
MDC responds to technical inquiries by providing analyzed data to assist the inquirer in solving a specific material removal problem.

MDC prepares and markets data publications and products on subjects of current interest to the User community in manufacturing technology.

The Center also conducts a seminar program consisting of a spring and a fall series of two-day seminars. This seminar program is designed to satisfy the requirements of managers, engineers and supervisors in the manufacturing community.

The Center maintains a selected mailing list of over 9,000 individuals who have expressed a desire to receive the Center's news bulletins and announcements of new products and new developments. The organization chart of the Machinability Data Center is shown in Figure 1.

FIGURE 1
MACHINABILITY DATA CENTER*
ORGANIZATION CHART



*Operated by Metcut Research Associates Inc.
under Contract DSA900-75-C-2071

MDC SERVICES

INQUIRY SERVICES

MDC processed a total of 292 inquiries during this reporting period. Of this total, only 58 were paid technical inquiries. The remainder were the no-charge, telephone-type inquiries, whereby the inquirer was provided information during the course of a telephone conversation without undue involvement of MDC personnel. Telephone inquiries are encouraged by MDC because they help maintain effective communications between the User community and MDC.

Table 1 summarizes the activity of MDC in processing technical inquiries during the period of this report. It should be noted that of the inquiries quoted, 200 of them were cancelled by the inquirer when the estimate of charges was provided. The income-to-cost ratio for processing inquiries and the percentage of total man-hours expended in answering inquiries appear satisfactory for the reporting period.

SEMINAR PROGRAM - "Practical Machining Principles for Shop Application"

MDC's seminar program was initiated by the Machinability Data Center in the spring of 1974. This program was designed to provide machining application principles and to upgrade the User community in the current methods of machining technology. The seminar program complements other information transfer objectives of MDC, namely, the sale of publications, computer programs and inquiry services.

Since the inception of the seminar program on "Practical Machining Principles for Shop Application" in the spring of 1974, two series of seminars have been held each year - one in the spring and one in the fall. Generally, six seminar programs have been presented in each series with capacity or near-capacity attendance.

The seminar program was initiated because of a demonstrated need to provide updated machining information for industry and government in order to decrease costs and to improve the productivity and the reliability of machined components. The program has been very well received by attendees including manufacturing engineers and managers, industrial engineers, process or methods engineers, tool engineers, N/C programmers, estimators, production planners, and shop personnel. The subject content of the seminar has been carefully selected and is continually being upgraded to present the latest ideas and techniques to the User community. The current program covers two full working days and includes the following discussions and presentations:

1. An Introduction to Practical Machining Principles
2. Cutting Tools
3. Cutting Fluids
4. Work Materials (Characteristics Affecting Machinability)
5. Selection of Speeds and Feeds
6. Machine Tool Operations
7. Economics of Machining
8. Numerical Control Machining
9. Surface Finish, Surface Integrity and Accuracy
10. Advanced Material Removal and Manufacturing Techniques
11. Nontraditional Machining Processes
12. Tour of Metcut Research Associates Inc. and the Machinability Data Center

During the period of this report, three seminar series were conducted - one in the fall of 1975 and one each in the spring and fall of 1976. During this time, a total of 19 two-day seminar programs were conducted by MDC and attended by 630 individuals representing Government and private industry. The contribution of the seminar program to total information transfer is further enhanced by the ability of the individual attendees to further disseminate their new knowledge to other production engineers and supervisors throughout their organizations.

The summary of the seminar program (Table 2) now shows that 1,188 individuals representing 589 companies from 40 states have attended 39 seminar sessions since they were begun in the spring of 1974. Table 13-A lists organizations that have been represented to date in this seminar program, and Table 13-B lists those organizations represented by four or more attendees.

DATA PUBLICATIONS

One of the contractual goals of the Machinability Data Center is to satisfy User requirements for useful and authoritative information on material removal practices through the preparation, maintenance and provision of handbooks and data books. Widely circulated data books tend to minimize the need for general inquiry services. MDC has expended a significant portion of its resources during this reporting period to accomplish this stated objective. Three new MDC publications have been published and marketed:

1. *Machining: A Process Checklist*. Publication No. MDC 76-100. This pamphlet is, as the title implies, a checklist of the known material removal processes. It defines the major manufacturing process groups and identifies the energy forms which are utilized in the major manufacturing process groups. The publication then lists the acronyms and material removal processes accordingly in four energy groupings for mechanical material removal processes, nontraditional material removal processes, deburring processes, and finishing processes. The publication also contains a list of selected references.
2. *Nontraditional Machining Guide: 26 Newcomers for Production*. Publication No. MDC 76-101. This publication is a comprehensive, illustrated documentary on the place of nontraditional machining methods in today's production environment. It gives credence to the place of nontraditional machining methods in fabricating the high strength, hard-to-machine alloys and materials that are being used in greater quantities today. This publication provides insight as to where the nontraditional material removal processes may be utilized in a cost-effective manner for the manufacture of component parts that formerly were extremely difficult, if not impossible, to machine. This publication provides a summary of the 26 most prominent nontraditional machining processes - circa 1976.
3. *Group Technology: An Overview and Bibliography*. Publication No. MDC 76-601. This publication is a basic treatise on group technology. It defines the scope of group technology and explains how it relates to the manufacturing industry. This pamphlet also provides some basic applications and the

necessary input for starting a group technology system. Finally, it discusses the relationship of group technology and numerical control and of group technology and computer-aided manufacturing. An extensive bibliography of 480 selected references for further detailed investigations on group technology is included.

These new and timely publications have been well received by MDC's Users. A listing of publication sales is shown in Table 3.

Table 4 shows a list of the current MDC publications that are available for sale by the Data Center. A total of almost 19,000 copies of the *Machining Data Handbook*, now in the 5th Printing of the 2nd Edition, have been sold.

COMPUTER PROGRAMS

A computer program (NCECO) has been developed by MDC for sale to industry. Additionally, programmable calculator strips have been designed for use by shop and engineering personnel who may not have ready access to a computer.

Both NCECO and the calculator strips are applicable to N/C and conventional machine tools. They facilitate investigation and analysis of the many alternative machining conditions for production use. Economic machining conditions can be determined before a part is put into production; consequently, the machine tool producing the part can be operated to give the lowest part cost, or the maximum production rate, or some combination of both, depending upon production demands.

They can also be used for estimating costs, preparing quotations and determining areas where cost-effective improvement can be directed in view of new developments, such as increased labor and overhead rates, new tool materials and work material alternatives. Sales of computer programs and calculator strips are shown in Table 5.

INCOME FROM INFORMATION TRANSFER ACTIVITIES

Table 6 summarizes income distribution from MDC's information transfer activities during the period of this report. This table itemizes the income for each type of information transfer, namely, handbooks and other publications, computer programs and calculator strips, inquiries, and the popular seminar program. Information regarding the total activity of the Data Center during this reporting period is summarized in Table 12.

SOURCES OF MACHINING INFORMATION

The functions of the Machinability Data Center have been defined as those activities which involve the collection, evaluation, storage, retrieval and dissemination of information relating to all phases of material removal technology. These functions all relate to MDC's hard-copy document file, which is the basis for many of MDC's activities. Source publications from the United States and from important foreign sources are continually being reviewed by MDC personnel for addition to MDC's document holdings in order to keep abreast of the advancing machining technology of the industrial nations of the world. Activities of MDC relating to document acquisition during the period of this report are summarized in Table 7. It should be noted that of the documents screened, 1,185 documents contained significant information for addition to MDC's holdings while 715 source documents were considered nonsignificant, that is, contained no information of value to MDC's scope of activities. When source publications are determined to be nonproductive of meaningful information, they are then deleted from the list of source reference documents.

The status of MDC's hard-copy document file at the end of this reporting period is shown in Table 8. The total number of documents on hand at any given time is not cumulative because obsolete information is continually being purged from the files. The listed figures, then, represent the status of the file at the end of this reporting period.

Table 9 is a representative list of sources from which MDC receives documents for inclusion into its document file. This listing is current for these selected categories as of the last day of this reporting period. Source categories not enumerated include foreign and U.S. private industry, U.S. and foreign Government, U.S. journals accessed via abstracting services and others. Categories chosen, along with the number of sources listed in each, are as follows:

1.	Technical Universities and Colleges (foreign and domestic) . .	91
2.	Technical Societies, Associations and Research Organizations (foreign and domestic)	117
3.	U.S. Journals Presently Screened	44
4.	Overseas Journals Presently Screened	21
5.	Overseas Journals Accessed Via Abstracting Services	166
6.	Abstracting Services Used by MDC	5

The total number of document sources and a breakdown by different categories are shown in Table 8. Note that the total number of sources as well as the number of sources within a given category may change from period to period as sources judged to be nonproductive are deleted from the list and new sources are added.

SECONDARY DISSEMINATION OF MACHINING DATA

Primary dissemination of machinability data is accomplished by MDC through its various publications, seminars and technical inquiries. A very important source of data is MDC's well-known *Machining Data Handbook*. Government and industry's exposure to MDC's machinability data is increased by secondary dissemination through various periodicals, industry pamphlets and books. Listed below are some of the secondary sources which have made extensive use of data from the various editions of the *Machining Data Handbook*.

1. Ablaps for precision finishing.
Company brochure, Ablap Inc., Franklin, PA, 1974.
2. Basics of turning.
Rassegna Internazionale di Meccanica (International Review of Mechanics), N. 5, May 1976.
3. *Cutting and grinding fluids: Selection and application*.
R. K. Springborn, editor, Dearborn, MI: American Society of Tool and Manufacturing Engineers, 1967.
4. *Cutting tool material selection*.
H. J. Swinehart, editor, Dearborn, MI: American Society of Tool and Manufacturing Engineers, 1968.
5. Economic trade-offs in deburring.
L. K. Gillespie, Report No. BDX-613-1620, The Bendix Corporation, Kansas City, MO, 1976.
6. 18 per cent Nickel maraging steels, engineering properties.
Inco Europe Limited, London, England, 1976.
7. *Engineering design*.
J. Stevenson and R. A. Callander, Sidney, Australia: John Wiley & Sons Australasia Party Limited, 1974.
8. Facts about machining titanium.
Reactive Metals, Inc., Niles, OH, 1968.
9. *Gray and ductile iron castings handbook*.
C. F. Walton, editor, Cleveland, OH: Gray and Ductile Iron Founders' Society Inc., 1971.
10. *Gundrilling, trepanning, and deep-hole machining*.
H. J. Swinehart, editor, Dearborn, MI: American Society of Tool and Manufacturing Engineers, 1967.
11. Machinability of metals as related to precision miniature parts.
L. K. Gillespie, The Bendix Corporation, Kansas City, MO, 1976.
12. Machine tool technology M.S. 101.
V. A. Roper, L. Morris, Utah Technical College, Provo, UT, 1974.
13. Machining data guide.
R. L. Eidson, Lockheed Missiles & Space Co., Inc., Sunnyvale, CA, 1973.

14. Machining data handbook - Tool materials.
The Carbide Journal, Vol. 4 (June/July 1972), pp. 4-10.
15. *Machining of malleable iron*.
N. Zlatin, M. Field, J. F. Kahles, Cleveland, OH: Malleable Founders Society, 1971.
16. *Manufacturing processes and materials for engineers*.
L. E. Doyle, 3d ed., Englewood Cliffs, NJ: Prentice-Hall, Inc., to be published 1978.
17. *Metal progress databook*.
H. E. Chandler, editor, Metals Park, OH: American Society for Metals, issued annually.
18. *Metals handbook, volume 3: Machining*.
American Society for Metals, Metals Park, OH, 1967.
19. *Modern plastics encyclopedia*.
J. Agranoff, editor, New York, NY: McGraw-Hill Inc., issued annually.
20. *N/C machinability data systems*.
N. R. Parsons, editor, Dearborn, MI: Society of Manufacturing Engineers, 1971.
21. *Plastics engineering handbook of the Society of the Plastics Industry, Inc.*
J. Frados, editor, New York, NY: Van Nostrand Reinhold, 1976.
22. *Producibility/machinability of space-age and conventional materials*.
R. E. Howe, editor, Dearborn, MI: American Society of Tool and Manufacturing Engineers, 1968.
23. *Production engineering handbook*.
B. A. Moski, Englewood Cliffs, NJ: Prentice-Hall, Inc., to be published 1978.
24. *The superalloys*.
C. T. Sims, editor, New York, NY: John Wiley & Sons, 1972.
25. Tap guide, selecting the right tap & treatment for the material.
T.R.W. Greenfield Tap & Die Div., Greenfield, MA, 1976.
26. Turnacut manual.
Lodge & Shipley Co., Cincinnati, OH, 1973.

ECONOMIC ANALYSIS OF MDC'S OPERATIONS

Table 10 is a statistical analysis of the accumulative effect of the operation of the Machinability Data Center towards costs savings. The numbers used in the computations include the total number of inquiries answered by the Data Center since its beginning and the total number of data publications sold and/or placed in distribution by the Data Center. The other input is the dollar savings per machining situation and the average number of machining situations serviced by each inquiry and/or individual data publication. These figures are then totaled to produce a dollar value which is the estimated total savings resulting from the operation of the Machinability Data Center.

Table 11 is an analysis of the cost of the metal cutting industry in the United States. These figures include the total number of metal cutting machine tools in use today and the average labor input plus the cost of labor and overhead for an average number of hours per individual working year. The estimates of the number of machine tools are extracted from the American Machinist Eleventh Inventory (1973). The other basic information is provided by U.S. Department of Commerce sources.

TABLE 1. - INQUIRY ACTIVITY
(August 1975 - December 1976)

Paid technical inquiries	58
No-charge (telephone) inquiries	234
Total inquiries processed	292
Inquiries quoted	258
Income from paid inquiries	\$ 6,683.00
Average income per paid inquiry	\$ 115.00
Cost of inquiry services	\$ 15,374.00
% Cost recovery for inquiry processing	43.5
Total income from all sources	\$191,115.00
% Income from inquiry services	3.5
Man-hours expended in inquiry processing	547
Total man-hours for Center operation	15,437
% Man-Hours for inquiry services	3.5

<u>INQUIRIES BY TYPE</u>	<u>Paid</u>	<u>No Charge</u>
High temperature alloys	13	47
Cutting fluids	1	6
Cutting tools	5	17
Surface integrity	6	19
Nontraditional machining processes	10	53
Cost	4	5
CAD/CAM	1	2
General machining	18	83
Bibliography	0	2
TOTAL	58	234

<u>INQUIRIES BY SOURCE</u>	<u>Paid</u>	<u>No Charge</u>
Government		
DoD	1	17
Non-DoD	0	3
Educational institutions	5	2
Private industry	52	212
TOTAL	58	234

TABLE 2. - SEMINAR PROGRAMS

	During this Contract Period	1974 - 1976*
Two-day seminars held	19 [†]	39 [†]
Attendees	630	1,188
Organizations represented	---	589
States represented	---	40

*Totals are cumulative from Spring 1974 through Fall 1976.

[†] Includes one seminar planned during this contract period that was held in January 1977 to handle overflow from the fall series.

TABLE 3. - LIST OF CURRENT MDC PUBLICATIONS

MACHINING DATA HANDBOOK, Second Edition, 1972, 1029 pages, 8 x 10½ in., hardbound.

MACHINING: A Process Checklist, MDC 76-100, 20 pages, 5½ x 8½ in., paperbound.

NONTRADITIONAL MACHINING GUIDE: 26 Newcomers for Production, MDC 76-101, 74 pages, 5½ x 8½ in., paperbound.

GROUP TECHNOLOGY: An Overview and Bibliography, MDC 76-601, 90 pages, 5½ x 8½ in., paperbound.

MACHINING OF HIGH STRENGTH STEELS WITH EMPHASIS ON SURFACE INTEGRITY, AFMDC 70-1, 268 pages, 8½ x 11 in., hardbound.

DETERMINATION AND ANALYSIS OF MACHINING COSTS AND PRODUCTION RATES USING COMPUTER TECHNIQUES, AFMDC 68-1, 124 pages, 8½ x 11 in., paperbound.

1968 SUPPLEMENT TO MACHINING DATA FOR NUMERICAL CONTROL, AFMDC 68-2, 104 pages, 8½ x 11 in., paperbound.

MACHINING DATA FOR NUMERICAL CONTROL, AFMDC 66-1, 270 pages, 8½ x 11 in., paperbound.

GRINDING RATIOS FOR AEROSPACE ALLOYS, AFMDC 66-2, 20 pages, 8½ x 11 in., paperbound.

MACHINING DATA FOR BERYLLIUM METAL, AFMDC 66-3, 26 pages, 8½ x 11 in., paperbound.

MACHINING DATA FOR TITANIUM ALLOYS, AFMDC 65-1, 56 pages, 5½ x 8½ in., paperbound.

TABLE 4. - SALES OF MACHINING DATA PUBLICATIONS

Machining Data Handbook, 2nd Edition	2,263
New data publications	
Machining: A Process Checklist . . .	547
Nontraditional Machining Guide . . .	331
Group Technology	<u>325</u>
Total	1,203
Data publications (prior contracts)	<u>578</u>
Grand Total	4,044

TABLE 5. - SALES OF COMPUTER PROGRAMS AND
PROGRAMMABLE CALCULATOR STRIPS
(August 1975 - December 1976)

NCECO (NC ECONomics) computer program . . .	9
Calculator strips	11

TABLE 6. - INCOME DISTRIBUTION FROM MDC INFORMATION
TRANSFER ACTIVITIES
(August 1975 - December 1976)

Inquiries	\$ 6,683
Seminars	111,963
Machining Data Handbook	59,325
Other data publications	10,564
Computer programs and calculator strips . .	<u>2,580</u>
TOTAL	\$191,115

TABLE 8. - STATUS OF MDC DOCUMENT FILES
(as of December 31, 1976)

DOCUMENT FILE TOTALS*

Regular file	24,794
Surface integrity file	2,886
Inquiry file	7,503
TOTAL [†] . .	35,183

BREAKDOWN OF SOURCE FILE

DoD sources [§]	56
Educational institutions	91
Government, Non-DoD	17
Nongovernment open literature	
Domestic	864
Foreign	454
TOTAL . .	1,482

DOCUMENT TOTALS BY SOURCE

DoD	1,428
Other Government	282
Nongovernment	
Domestic	25,725
Foreign	7,748
TOTAL . .	35,183

*Regular file - refers to the main document file which supports MDC's activities. Surface integrity file - refers to a segment of the main file pertaining to the special subject of surface integrity. Inquiry file - Inquiries are coded and filed in a similar manner to other documents and are used to assist in answering specific technical inquiries.

[†]The document file totals reflect the status of the files as of the reporting date after the addition of new source documents and the deletion of obsolete documents.

[§]DoD sources - includes DoD installations plus companies and educational institutions which generate source documents under Government contract and other source documents which result from their own research.

TABLE 7. - DOCUMENT ACQUISITION
(August 1975 - December 1976)

DOCUMENTS SCREENED*	
Significant	1,185
Nonsignificant	<u>715</u>
TOTAL	1,900
DOCUMENTS ACCESSED [†]	
Primary	718
Secondary	<u>1,277</u>
TOTAL	1,995
DOCUMENTS ENTERED INTO SYSTEM [§]	2,140

*Documents screened - refers to all types of publications, including periodicals, trade journals, conference proceedings, etc.

[†]Documents accessed - refers to those which have been selected for entry into MDC's document file. Secondary documents include such references as an article extracted from a periodical or an individual technical paper selected from a published volume of conference proceedings, etc. Primary documents include source data, such as contractor reports, which are entered into the system as received. Documents in this category are counted in the inventory of MDC's total data base.

[§]Documents entered into the system include primary and secondary documents which have been coded and referenced on the computer search files.

TABLE 9. - REPRESENTATIVE LIST OF MDC'S SOURCES OF INFORMATION

TECHNICAL UNIVERSITIES AND COLLEGES

Aachen Technical University (West Germany)
 University of Arizona
 Berlin Technical University (East Germany)
 Birmingham University (Great Britain)
 Braunschweig Technical University (West Germany)
 University of Bridgeport
 Brown University
 Cairo University (Egypt)
 University of California
 Cambridge University (Great Britain)
 Carnegie-Mellon University
 Case Western Reserve University
 Chalmers' University of Technology (Sweden)
 University of Chicago
 University of Cincinnati
 Cleveland State University
 Columbia University
 Cornell University
 Cranfield Institute of Technology (Great Britain)
 University of Dayton
 Delft Technological University (Netherlands)
 University of Denver
 Dresden Technical University (East Germany)
 Eindhoven Technical University (Netherlands)
 University of Florida
 George Washington University
 Hannover Technical University (West Germany)
 Harvard University
 University of Houston
 University of Illinois
 Indian Institute of Technology (India)
 Johns Hopkins University
 Kansas State University
 Karl Marx Stadt Technical University (East Germany)
 Karlsruhe Technical University (West Germany)
 Catholic University at Leuven (Belgium)
 Kharkov Polytechnical Institute (USSR)
 Kyoto University (Japan)
 Lehigh University
 Leningrad Polytechnical Institute (USSR)
 University of Manchester (Great Britain)
 Massachusetts Institute of Technology
 McMaster University (Canada)
 University of Melbourne (Australia)
 University of Michigan
 University of Minnesota
 University of Missouri
 New York University
 North Carolina State University
 Northern Illinois University
 Northwestern University
 Norway Technical University (Norway)

Norwich University (Great Britain)
University of Nottingham (Great Britain)
Ohio State University
Oklahoma State University
University of Oregon
Osaka University (Japan)
Pennsylvania State University
Pisa University (Italy)
Purdue University
Queen's University of Belfast (Ireland)
Queen's University (Canada)
Rensselaer Polytechnic Institute of Connecticut
University of Rhode Island
University of Rochester
University of Roorkee (India)
Royal Institute of Technology (Sweden)
Rutgers University
University of South Hampton (Great Britain)
University of Southern California
Stanford University
State University of New York
University of Strathclyde (Great Britain)
Syracuse University
Technion-Israel Institute of Technology (Israel)
Texas A & M University
Texas Technological University
University of Texas
University of Tokyo (Japan)
Tokyo Institute of Technology (Japan)
University of Trondheim (Norway)
Turin Polytechnic Institute (Italy)
University of Uppsalla (Sweden)
Utah University
Vanderbilt University
Virginia Polytechnic Institute
University of Washington
West Virginia University
University of Wisconsin
Yokohama National University (Japan)

TECHNICAL SOCIETIES, ASSOCIATIONS AND RESEARCH ORGANIZATIONS

Abrasive Engineering Society
Academy of Sciences (USSR)
Aerospace Industries Association of America
Advisory Group for Aerospace Research & Development (France)
Aluminum Association
Aluminum Development Council of Australia (Australia)
American Ceramic Society
American Defense Preparedness Association
American Federation of Information Processing Societies
American Foundrymen's Society
American Gas Association
American Gear Manufacturers Association
American Helicopter Society
American Institute of Mining, Metallurgical & Petroleum Engineers

American Institute of Aeronautics and Astronautics
 American Institute of Chemical Engineers
 American Institute of Physics
 American Iron and Steel Institute
 American Machine Tool Distributors Association
 American Metal Stamping Association
 American National Standards Institute
 American Nuclear Society
 American Powder Metallurgy Institute
 American Society for Metals
 American Society for Nondestructive Testing
 American Society for Quality Control
 American Society for Testing & Materials
 American Society of Lubrication Engineers
 American Society of Mechanical Engineers
 American Welding Society
 Battelle Memorial Institute
 British Cast Iron Research Association (Great Britain)
 British Hydrodynamics Research Association (Great Britain)
 British Standards Institution (Great Britain)
 Broaching Tool Institute
 Cast Metals Federation
 Cemented Carbide Producers Association
 Centre de Recherches Scientifiques et Techniques de l'Industrie des
 Fabrications Metalliques (Belgium)
 Centre Technique des Industries Mechaniques (France)
 Coated Abrasives Manufacturers Institute
 Computer Aided Manufacturing - International
 Copper Development Association
 Cutting Tool Manufacturers Association
 Deutsche Edelstahlwerke Aktiengesellschaft (West Germany)
 Deutsche Gesellschaft fuer Luft- und Raumfahrt (West Germany)
 Diamond Wheel Manufacturers Institute
 Electronic Industries Association
 Engineering Institute of Canada (Canada)
 Engineering Sciences Data Unit (Great Britain)
 Federal Association of the German Aerospace Industry (West Germany)
 Franklin Institute
 French Society for Testing and Construction of Aircraft Motors (France)
 Gray and Ductile Iron Founders Society
 Grinding Wheel Institute
 Groupement pour l'Avancement de la Mechanique Industrielle (France)
 Industrial Diamond Association of America
 Institute of Electrical & Electronics Engineers
 Institute of Machine Tools & Tooling (Yugoslavia)
 Institute of Metallurgical and Applied Research (Switzerland)
 Institute of Physical and Chemical Research (Japan)
 Institution of Engineers (Great Britain)
 Institution of Engineers (India)
 Institution of Mechanical Engineers (Great Britain)
 Institution of Production Engineers (Great Britain)
 Institutut Politshnic din Timisoaro (Rumania)
 Instrument Society of America
 International Institution for Production Engineering Research (France)
 International Lead Zinc Research Organization
 International Organization for Standardization (Switzerland)
 Iron Castings Society

Japan Copper Development Association (Japan)
 Japan EDM Society (Japan)
 Japan Institute of Metals (Japan)
 Japan Society of Mechanical Engineers (Japan)
 Japan Society of Precision Engineering (Japan)
 Joint Industrial Council
 Komissiya Po Tekhnologii Mashinostroyeniya (USSR)
 Machine Tool Industry Research Association (Great Britain)
 Machinery and Allied Products Institute
 Malleable Founders' Society
 Metaalinstituut TNO (Netherlands)
 Metal Cutting Tool Institute
 Metal Powder Industries Federation
 Metals Society (Great Britain)
 Midwest Research Institute
 National Association of Corrosion Engineers
 National Bureau of Standards
 National Machine Tool Builders Association
 National Research Council of Canada (Canada)
 National Science Foundation
 National Screw Machine Products Association
 National Tool, Die and Precision Machining Association
 Non-Ferrous Founders' Society (Great Britain)
 Numerical Control Society
 Organization for Economic Co-Operation & Development (France)
 Photochemical Machining Institute
 Production Engineering Research Association (Great Britain)
 Royal Swedish Academy of Engineering Sciences (Sweden)
 Society for Experimental Stress Analysis
 Society for the Advancement of Material and Process Engineering
 Societe Francaise de Metallurgia (France)
 Society of Automotive Engineers
 Society of Carbide and Tool Engineers
 Society of Die Casting Engineers
 Society of Manufacturing Engineers
 Society of Material Science (Japan)
 Society of Photo-Optical Instrumentation Engineers
 Society of Plastics Engineers
 Society of the Plastics Industry
 Southwest Research Institute
 Steel Founders' Society of America
 Swedish Association of Metalworking Industries (Sweden)
 Swedish Institute of Production Engineering Research (Sweden)
 Weiser Hirsch Research Institute (East Germany)
 Welding Institute (Great Britain)
 Zinc Alloy Die Casters Association
 Zirconium Association

U.S. JOURNALS PRESENTLY SCREENED

American Machinist
 American Metal Market/Metalworking News
 Astronautics and Aeronautics
 Automatic Machining
 Automation
 Automotive Engineering

Aviation Week and Space Technology
 Carbide Journal
 Ceramic Industry
 Cutting Tool Engineering
 Experimental Mechanics
 International Cast Metals Reviews
 Iron Age
 Journal of Engineering for Industry, ASME Transactions
 Journal of Engineering Materials & Technology, ASME Transactions
 Journal of Metals
 Journal of Testing and Evaluation
 Light Metal Age
 Machine and Tool Blue Book
 Machine Design
 Manufacturing Engineering
 Materials Engineering
 Materials Evaluation
 Mechanical Engineering
 Metal Finishing
 Metal Progress
 Metallurgical Transactions A: Physical Metallurgy and Materials Science
 Metallurgical Transactions B: Process Metallurgy
 Metals Engineering Quarterly
 Modern Casting
 Modern Machine Shop
 Modern Metals
 NAVMIRO Manufacturing Technology Bulletin
 N/C Commline
 Quality
 Quality Progress
 Research/Development
 SAE Transactions
 SAMPE Journal
 Standardization News
 Tooling & Production
 Transactions of the American Foundrymen's Society
 Welding Journal

OVERSEAS JOURNALS PRESENTLY SCREENED

Annals of the CIRP
 Australian Machinery and Production Engineering
 Bulletin of the Japan Society of Precision Engineering
 Canadian Machinery and Metalworking
 CETIM Informations
 Engineering Materials & Design
 Industrial Diamond Review
 International Journal of Machine Tool Design and Research
 International Journal of Production Research
 International Metals Reviews
 Machine-Tool Review
 Machinery and Production Engineering
 Machinery Lloyd
 Machines and Tooling
 Manufacturing Systems
 Metallurgia and Metal Forming

Metalworking Production
Microtecnic
Production Engineer
Russian Engineering Journal
Tooling

OVERSEAS JOURNALS ACCESSED VIA ABSTRACTING SERVICES

AEI Engineering
Acta Metallurgica
Acta Polytechnica Scandinavica
Acta Technica
Aeronautical Quarterly
Akademiya Nauk SSR
Alloy Metals Review
Aluminum
Archiv fur das Eisenhuttenwesen
Archiv fur Metallkunde
Asahi Evening News
Australasian Engineer
Australian Journal of Applied Science
Australian Mechanical Engineering
Automatic Welding
Aviatsionnyy Tekhnologicheskii Institut, Trudy
Berg- und Huttenmannische Monatshefte
British Corrosion Journal
British Foundryman
British Journal of Applied Physics
British Journal of Industrial Medicine
British Machine Tool Engineering
British Welding Journal
Bulletin of the Research Council of Israel
Bulletin of the Academy of Sciences of the Kirgiz, SSR
Bulletin of the Academy of Sciences (USSR)
Bulletin of the Japan Society of Mechanical Engineers
Bulletin of the Tokyo Institute of Technology
Canadian Journal of Physics
Chartered Mechanical Engineer
Control and Instrumentation
Corrosion Engineer
Electrical Review
Energia Nucleare
Energomashinostroyeniye
The Engineer
Engineering Journal
Engineers Digest
Feingeratetechnik
Fertigung
Fertigungstechnik und Betrieb
Fizika Metalov i Metallovedenie
Fiziko Khimicheskaya Mekhanika Materialov
Freiberger Forschungsheft
FWP Journal
Galvanotechnik
High Temperatures - High Pressures
Indian Journal of Technology

Industrial Finishing
 Industrie-Anzeiger
 Industrieblatt
 International Journal of Fracture
 International Journal of Mechanical Sciences
 Israel Journal of Technology
 Izvestiya Khar Kovskgo Tekhnologicheskogo Instituta
 Izvestiya Vysshikh Uchebnykh Zavedenii
 Japanese Journal of Applied Physics
 Jernkontorets Annoler
 Journal of Mechanical Engineering Science
 Journal of Institution of Engineers, India
 Journal of Mechanical Laboratory of Japan
 Journal of Microelectronics and Reliability
 Journal of Scientific & Industrial Research
 Journal of Strain Analysis
 Journal of Technical Physics
 Journal of the Aeronautical Society of India
 Journal of the Australian Institute of Metals
 Journal of the Faculty of Engineering, Tokyo
 Journal of the Indian Rocket Society
 Journal of the Industrial Engineer
 Journal of the Institute for Engineering
 Journal of the Institute of Metals
 Journal of the Iron and Steel Institute
 Journal of the Japan Institute of Metals
 Journal of Less Common Metals
 Journal of the Royal Aeronautical Society
 Konstruktion, Elemente, Methoden
 Kruppschemonatshefte
 Macchine-Guigno
 Machine Outil
 Machine Shop & Metalworking Economics
 Machine Tool Engineering
 Maschine, Die
 Maschinenbautechnik
 Maschinenmarkt
 Materialpruefung
 Mekhanika i Maschinostroenie
 Metal Construction & British Welding Journal
 Metal Finishing Journal
 Metal Science and Heat Treatment
 Metaalinstituut TNO Communications
 Metall
 Metalloberflache
 The Metallurgist and Materials Technologist
 Metals and Materials
 Metals Australia
 Metals Technology
 Metalworking Economics
 Nature
 Non-Destructive Testing
 Nuclear Engineering
 Optics and Laser Technology
 Planseeberichte fuer Pulvermetallurgie
 Plastics
 Powder Metallurgy International

Proceedings of the Institution of Electrical Engineers
 Radex-Rundschau
 Referativnyy Zhurnal, Metallurgiya
 Referativnyy Zhurnal, Tekhnologiya Mashinostroyeniya
 Refractories Journal
 Revue de Metallurgie
 Ricerca Scientifica
 Rivista de Meccanica
 Russian Castings Production
 S.E.R.L. Journal
 Sbornik Avtomatizatsii Kontrolya Teknol
 Sbornik Korrozion
 Sbornik Nauchno-Issledovatel'skikh Rabot Tashkentskogo Tekstil'nogo
 Instituta
 Sbornik Obrabaty Vayemost
 Sbornik Rabot Rostovoskogo-Na-Donn
 Scandanavian Journal of Metallurgy
 Schweissen und Schneiden
 Scientific Lubrication
 Scripta Metallurgica
 Sheet Metal Industries
 Society of Materials Science Journal
 Soviet Journal of Optical Technology
 Soviet Material Sciences
 Soviet Physics - Technical Physics
 Soviet Powder Metallurgy & Metal Ceramics
 Stahl und Eisen
 Stahlberatungstelle
 Stal
 Strain
 Strength of Materials
 Sumitomo Search
 Technica
 Technik, Die
 Technik und Betrieb
 Technique Moderne
 Technische Mitteilungen Krupp
 Technische Rundschau
 Technische Zeitschrift fuer Praktische Metallbearbeitung
 Toshiba Review
 Transactions of the Danish Academy of Technical Science
 Transactions of the Indian Institute of Metals
 Transactions of the Institute of Metal Finishing
 Transactions of the Japan Institute for Metals
 Transactions of the Japan Society of Mechanical Engineers
 Ultrasonics
 VDI Zeitschrift
 VDI Berichte
 Vechernyaya Moskva
 Vestnik Mashinostroyeniya
 Vestnik Metallopromyshlennosti
 Wear
 Welding and Metal Fabrication
 Welding Production
 Werkstatt und Betrieb
 Werkstattstechnik
 Werkzeug Maschine International

Wire
Wire Industry
Zeitschrift fuer Angewandte und Physik
Zeitschrift fuer Metallkunde
Zeitschrift fuer Wirtschaftliche Fertigung

ABSTRACTING SERVICES USED BY MDC

Government Reports Announcements, NTIS, Springfield, Virginia.
International Aerospace Abstracts, American Institute of Aeronautics and
Astronautics, New York.
Metals Abstracts, American Society for Metals, Metals Park, Ohio.
NASA Technical Briefs, NASA Technology Utilization Office, Washington, DC.
Scientific and Technical Aerospace Reports, NASA Scientific and Technical
Information Office, Baltimore, Maryland.

TABLE 10. - CALCULATION OF ESTIMATED COST SAVINGS RESULTING FROM MDC'S OPERATION
(October 1964 - December 1976)

	Number Sold	Machining* + Situations Utilized per Item	Total* Machining Situations Utilized	Savings per* Machining Situation	Estimated Cost Savings
INQUIRIES	7,503	5	37,515	x \$800	= \$ 30,012,000
MACHINING DATA HANDBOOKS					
ORDP 40-1 ^s	4,500				
1st edition [#]	15,000				
2nd edition	18,686				
OTHER PUBLICATIONS ^{††}	38,186	10**	381,860	x \$300	= \$114,558,000
	24,829	5**	124,145	x \$300	= \$ 37,243,500
				TOTAL	\$181,813,500

*Estimated.

†Machining situations utilized per item refers to each inquiry answered or each publication sold.

§forerunner of *Machining Data Handbook*. These copies were sold by the U.S. Government.

#Includes 9,000 hardbound + 6,000 softbound copies. The 6,000 softbound copies were sold by the U.S.

Government.

**These estimates are very conservative. They reflect only 10 and 5 usages respectively for the life of each publication sold.

††Excluding *Machining Data Handbook*.

TABLE 11. - MACHINING COSTS IN THE U.S.A.

APPROXIMATE ANNUAL LABOR AND OVERHEAD COSTS FOR OPERATING METAL CUTTING MACHINE TOOLS IN INDUSTRIES IN THE UNITED STATES

Total number of metal cutting machine tools	= 2,692,000*
Average labor cost + overhead	= \$10-12 per hour
Average working day	= 8 hours
Number of working days per year	= 250
Average number of direct labor personnel per machine	= 1
Total cost of labor + overhead:	
2,692,000 x \$10 x 8 x 250 x 1	= \$53,840,000,000
2,692,000 x \$12 x 8 x 250 x 1	= \$64,608,000,000

It appears reasonable to conclude that the cost of labor + overhead for machining required for manufacturing in the U.S.A. is on the order of:

\$60,000,000,000 Annually

TOTAL SHIPMENTS INCLUDING EXPORTS OF METAL CUTTING TYPE METALWORKING MACHINERY +

<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976 (estimate)</u>
\$1,206,000,000	\$1,517,000,000	\$1,776,000,000	\$1,710,000,000

MACHINE TOOL ACCESSORIES INDUSTRY[†]

Small cutting tools for machine tools and metalworking machinery in the amount of:

<u>1973</u>	<u>1974</u>	<u>1975 (estimate)</u>	<u>1976 (estimate)</u>
\$841,000,000	\$1,129,000,000	\$1,020,000,000	\$1,160,000,000

ANNUAL COST OF CUTTING FLUIDS FOR MATERIAL REMOVAL OPERATIONS[§]

\$160,000,000

NOTE: The statistics above provide perspective concerning the economic importance of metal cutting (machining and grinding) in the U.S.A.

SOURCES: *Based on American Machinist Eleventh Inventory (1973)

[†]U. S. Department of Commerce

[§]MDC estimate (1976)

TABLE 12. - STATISTICAL SUMMARY FOR AUGUST 1, 1975 - DECEMBER 31, 1976

INFORMATION ANALYSIS CENTER CONTRACT STATUS REPORT		NAME OF INFORMATION ANALYSIS CENTER Machinability Data Center				QUARTER ENDING		CUMULATIVE THRU July 1975	
AREA TITLE	OUTPUT UNITS PRODUCED	MANHOURS EXPENDED			COSTS INCURRED			INCOME	
		PRO- FESSIONAL	NON-PRO- FESSIONAL	TOTAL	DIRECT	INDIRECT	TOTAL		
1. ACQUISITION AND INPUT OF SOURCE INFORMATION		2,534	1,658	4,192	45,662	54,400	100,062		
a. DOCUMENTS ACQUIRED	1,810								
b. DOCUMENTS REVIEWED	2,118								
c. DOCUMENTS CATALOGED	1,661								
2. TECHNICAL INQUIRY RESPONSES PROVIDED	226	500	47	547	7,420	7,954	15,374	6,683	
3. BIBLIOGRAPHIC PUBLICATIONS IN PROGRESS	-	154	25	179	1,501	2,581	4,082		
4. HANDBOOKS/ DATA BOOKS		372	75	447	5,038	6,122	11,160	72,469	
a. NEW CHAPTERS/PAGES COMPLETED									
b. REVISED CHAPTERS/PAGES COMPLETED									
c. DATA SETS COMPILED									
5. STATE-OF-THE-ART STUDIES COMPLETED		1,486	11	1,497	17,768	26,840	44,608		
6. CRITICAL REVIEWS AND/OR TECHNOLOGY ASSESSMENTS COMPLETED		115	-	115	904	1,491	2,395		
7. CURRENT AWARENESS AND PROMOTION EFFORTS		4,650	879	5,529	121,201	80,167	201,368	111,963	
a. NUMBER NEWSLETTERS AND/OR ANNOUNCEMENTS PUBLISHED	8								
b. NUMBER MEETINGS, CONFERENCES, ETC. SUPPORTED	29								
8. OTHER									
9. MANAGEMENT AND SUPPORT		2,031	900	2,931	28,805	39,349	68,154		
10. UNASSIGNABLE INDIRECT COSTS									
11. TOTAL		11,842	3,595	15,437	228,299	218,904	447,203	191,115	

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EDITION OF JUN 72 IS OBSOLETE

TABLE 13-A.
 ORGANIZATIONS REPRESENTED AT MDC'S SEMINARS ON
 "PRACTICAL MACHINING PRINCIPLES FOR SHOP APPLICATION"
 (Spring 1974 - Fall 1976)*

<u>Company</u>	<u>No. of Attendees</u>
AMP, Inc., Harrisburg, PA	1
ARO, Inc., Arnold Air Force Station, TN	15
ASKO Inc., Homestead, OH	1
Abex Corp., Marysville, OH	2
Acimet Manufacturing Corp., Cleveland, OH	1
Adams Tool & Engineering Co., Lansing, MI	2
Aero Nuclear Corp., Bentleyville, PA	1
Aeroquip Corp., Leslie, MI	1
Aeroquip Corp., Van Wert, OH	8
Aerospace Materials, Inc., Columbus, OH	1
AiResearch Manufacturing Co., Phoenix, AZ	4
Allen-Bradley Co., Highland Heights, OH	1
Allen-Bradley Co., Milwaukee, WI	1
Allis-Chalmers Corp., Cincinnati, OH	8
Allis-Chalmers Corp., Milwaukee, WI	2
Allis-Chalmers Corp., West Allis, WI	3
Allis-Chalmers Corp., York, PA	16
Aluminum Co. of America, Alcoa Center, PA	1
American Can Co., Geneva, NY	1
American Machinist, New York, NY	1
Anchor Coupling Co., Inc., Libertyville, IN	1
Anderson Greenwood, Bellaire, TX	2
Anderson Instrument Co., Inc., Fultonville, NY	1
Anderson Metal Industries Inc., Mercer, PA	1
Andrew Corp., Orland Park, IL	4
Ansul Co. (The), Marinette, WI	1
Apex Broach & Machine Co., Detroit, MI	2
Apollo Tool & Design, Dayton, OH	1
Applied Industries Inc., Center Line, MI	1
Armco Steel Corp., Middletown, OH	1
Armstrong Machine Works, Three Rivers, MI	3
Ashland Oil, Inc., New Carlisle, IN	1
Atlas Corp., Springfield, MA	1
Atwood & Morrill Co. Inc., Salem, MA	2
Aurora Metal Co., Montgomery, IL	2
Auspro Manufacturing Co., Inc., Elkhart, IN	1
Automated Industries Inc., Oak Ridge, TN	1
Automatic Feed Co., Napoleon, OH	1
Avco Corp. (Lycoming Div.), Stratford, CT	2
Babcock & Wilcox Co., Barberton, OH	14
Babcock & Wilcox Co., Beaver Falls, PA	1
Babcock & Wilcox Co., Elkhart, IN	1
Babcock & Wilcox Co., Lynchburg, VA	4
Babcock & Wilcox Co., Paris, TX	1
Babcock & Wilcox Co., Rochester, MI	1

*Includes one seminar planned during this contract period that was held in January 1977 to handle overflow from the fall series.

<u>Company</u>	<u>No. of Attendees</u>
Baj Tool Co., Willoughby, OH	1
Baker Perkins Inc., Saginaw, MI	2
Ball Brothers Research Corp., Boulder, CO	1
Banta Machine Corp., Ridgefield, NJ	1
Barber-Coleman Co., Rockford, IL	2
Barnes Co., W. F. & John, Rockford, IL	1
Battelle Northwest, Richland, WA	3
Bell Helicopter Co., Ft. Worth, TX	2
Bell Helicopter Co., Hurst, TX	2
Bell Telephone Labs., Holmdel, NJ	1
Bell Telephone Labs., Murray Hill, NJ	1
Beloit Corp. (Jones Div.), Dalton, MA	1
Bendix Corp. (I.T.D. Div.), Greenfield, MA	1
Bendix Corp., South Bend, IN	3
Berg Manufacturing Co., Des Plaines, IL	1
Berg Manufacturing Co., Iola, KS	2
Berkeley-Davis Inc., Danville, IL	2
Bethlehem Steel Corp., Baltimore, MD	1
Bingham Willamette Co., Shreveport, LA	2
Black Clawson Co., Middletown, OH	1
Bliss & Laughlin Industries, Evansville, IN	1
Boeing Vertol Co., Philadelphia, PA	3
Brad Foote Gear Works, Inc., Cicero, IL	1
Brake Parts Co., McHenry, IL	1
Brighton Corp., Cincinnati, OH	1
Brothers Industries, Warren, MI	1
Brown & Sharpe Manufacturing Co., Centerdale, RI	1
Brown & Sharpe Manufacturing Co., No. Kingstown, RI	1
Brush Wellman, Inc., Elmore, OH	1
Buckeye Steel Castings, Columbus, OH	1
Buehler Corp. (The), Indianapolis, IN	1
Bullard Co., Bridgeport, CT	1
Burroughs Corp., Plymouth, MI	1
C-E Process Equipment Mfg. Facility, Enterprise, KS	1
C R M, Solon, OH	1
Cablecraft, Inc., Tacoma, WA	2
Cabot Corp., Kokomo, IN	2
Cameron Iron Works, Inc., Houston, TX	1
Carlton Machine Tool Co., Cincinnati, OH	1
Carlyle Compressor Co., East Syracuse, NY	1
Carmet Company, Lima, OH	1
Carmet Company, Madison Heights, MI	1
Carpenter Technology Corp., Reading, PA	3
Carr Tool Co., Cincinnati, OH	1
Case, J. I., Co., Winneconne, WI	1
Caterpillar Tractor Co., East Peoria, IL	3
Cava Industries, Essington, PA	1
Chamberlain Mfg. Corp., New Bedford, MA	4
Champion Spark Plug, Toledo, OH	1
Chemetron Corp., Louisville, KY	6
Cherry-Burrell Co., Cedar Rapids, IA	2

<u>Company</u>	<u>No. of Attendees</u>
Chicago Pneumatic Tool Co., Utica, NY	1
Chrysler Corp., Dearborn, MI	1
Chrysler Corp., Detroit, MI	1
Chrysler Corp., Kokomo, IN	6
Chrysler Corp., New Castle, IN	1
Cincinnati, Inc., Cincinnati, OH	5
Cincinnati Milacron Inc., Cincinnati, OH	2
Cincinnati Mine Machinery Co. (The), Cincinnati, OH	1
Cincinnati Metal-Blast, Inc., Cincinnati, OH	1
Cincinnati Technical College, Cincinnati, OH	1
Cincinnati Tool, Cincinnati, OH	2
Cincinnati, University of, Cincinnati, OH	2
Clark Equipment Co., Georgetown, KY	3
Clark Equipment Co., Rockingham, NC	1
Clayton Mark Co., Evanston, IL	1
Cleveland Hardware & Forging Co., Cleveland, OH	2
Cleveland Twist Drill Co., Cleveland, OH	1
Clow Corporation, Oskaloosa, IA	2
Clow Corporation, Westmont, IL	1
Columbian Vise Manufacturing, Cleveland, OH	1
Columbus McKinnon Corp., Damascus, VA	2
Combustion Engineering, Inc., Chattanooga, TN	1
Commercial Machine Works, Elk Grove, IL	1
Conax Corporation, Buffalo, NY	1
Cooper Bessemer Co., Mount Vernon, OH	1
Cooper Energy Services, Easton, PA	2
Cooper Energy Services, Mount Vernon, OH	1
Copeland Corp., Sidney, OH	1
Copperweld Specialty Steel Co., Warren, OH	3
Corning Community College, Corning, NY	1
Corning Glass Works, Corning, NY	1
Crane Co., Chicago, IL	2
Crepaco, Inc., Lake Mills, WI	1
Crosby Valve & Gage Co., Wrentham, MA	3
Cross Corp. (Fraser Div.), Fraser, MI	2
Cross Manufacturing Inc., Lewis, KS	2
Cummins Engine Co., Inc., Columbus, IN	6
Cummins Engine Co., Inc., North Charleston, SC	1
Cutler-Hammer, Inc., Bowling Green, KY	1
Cutler-Hammer, Inc., Milwaukee, WI	4
D.A.B. Industries Inc., Bellefontaine, OH	2
Dana Corp., Chelsea, MI	7
Danly Machine Corp., Cicero, IL	1
Dean Machine Products, Inc., Manchester, CT	2
Dearborn, Howard, Inc., Berea, OH	12
Dearborn, Howard, Inc., Fryeburg, ME	1
Dearborn Machine Products Co., Taylor, MI	1
Deere & Company, Moline, IL	3
Deere, John, Des Moines Works, Des Moines, IA	3
*Defense Contract Admin. Management Area, Cincinnati, OH	5

*Department of Defense

<u>Company</u>	<u>No. of Attendees</u>
Delaval Turbine Inc., Trenton, NJ	3
Delton Tool & Engineering, Inc., Delton, MI	1
Detroit Edge Tool Co., Detroit, MI	1
Deutsch Co. (The), (E.C.D. Div.), Banning, CA	1
Deutsch Co. (The), Oceanside, CA	2
DeVlieg Machine Co., Royal Oak, MI	1
DeZurik Corp., McMinnville, TN	2
Diamond Chain Co., Indianapolis, IN	5
Digital Equipment Corp., Westfield, MA	1
Discharge Machining, Inc., Cleveland, OH	1
Dixie Tool Industries Co., Bridgeport, MI	2
DoAll Co., Des Plaines, IL	1
Dover Corp., Chattanooga, TN	2
Dover Corp., Cincinnati, OH	2
Dover Corp. (Cook Airtomic Div.), Louisville, KY	2
Dresser Industries, Dallas, TX	1
Dresser Industries (Clark Div.), New Orleans, LA	2
Dresser Industries, Waukesha, WI	2
DuBois Chemicals, Cincinnati, OH	1
Duff-Norton Co., Charlotte, NC	2
Dupps Co. (The), Germantown, OH	1
Duriron Co. (The), Dayton, OH	2
Duval Sierrita Corp., Sahuarita, AZ	1
East Chicago Machine Tool Corp., East Chicago, IN	1
Eaton Corp., Cleveland, OH	2
Eaton Corp., Louisville, KY	1
Eaton Corp., Marshall, MI	4
Eaton Corp., Richmond, IN	4
Eaton Corp., Roxboro, NC	1
Eaton Corp., Saginaw, MI	1
Eaton Corp., St. Louis, MO	1
Eccles Saw & Tool Co. Inc., Cincinnati, OH	1
Edgewater Steel Co., Oakmont, PA	3
Elano Corp., Xenia, OH	2
Eldred Co. (The), Columbus, OH	1
Electric Machinery Mfg. Co., Minneapolis, MN	6
Electric Wheel Co., Quincy, IL	2
Elliott Corp., Irwin, PA	4
Eonics, Inc., Detroit, MI	2
Erie Bolt Corp, Erie, PA	1
Essick Manufacturing Co., Los Angeles, CA	1
Evans Products, Plymouth, MI	1
FAMA Inc., Monterrey, Mexico	3
FMC Corp., Englewood, NJ	1
FMC Corp., Houston, TX	1
FMC Corp., Indianapolis, IN	1
FMC Corp., Philadelphia, PA	2
Falk Corp., Milwaukee, WI	3

<u>Company</u>	<u>No. of Attendees</u>
Falon Co., Cleveland, OH	1
Fansteel Research Center, Salt Lake City, UT	1
Farrel Co.-Div. USM, Rochester, NY	1
Federal Mogul Corp., Greensburg, IN	2
Federal-Mogul Corp., Macomb, IL	1
Federal Sign & Signal Corp., Shelby, OH	1
Fenn Manufacturing Co., Newington, CT	2
Fisher Controls Co., Coraopolis, PA	3
Ford Motor Co., Detroit, MI	1
Foster Wheeler Energy Corp., Livingston, NJ	1
Freeport Machine Works, Freeport, IL	1
Fremont Manufacturing Co., Fremont, NB	1
Frick Co., Waynesboro, PA	1
Gaishin Tool & Fixture Inc., Riverview, MI	1
Garvin Brothers Inc., South Bend, IN	1
Gay-Lee Co., Clawson, MI	1
Gehl Co., West Bend, WI	2
Generac Corp., Waukesha, WI	1
General Casting Corp. Waukesha, WI	1
General Dynamics, Ft. Worth, TX	3
General Dynamics, San Diego, CA	2
General Electric Co., Cincinnati, OH	2
General Electric Co., Ft. Wayne, IN	1
General Electric Co., Greenville, SC	1
General Electric Co., Lynn, MA	1
General Electric Co., Merrimack, NH	1
General Electric Co., Philadelphia, PA	1
General Electric Co., St. Petersburg, FL	1
General Electric Co., San Jose, CA	2
General Electric Co., Schenectady, NY	3
General Electric Co., Southfield, MI	1
General Electric Co., Syracuse, NY	2
General Electric Co., Worthington, OH	2
General Motors Corp., Dayton, OH	4
General Motors Corp. (Detroit Diesel Allison), Indianapolis, IN	2
General Motors Corp. (Delco Electronics), Kokomo, IN	1
General Motors Corp. (Harrison Radiator Div.), Lockport, NY	1
General Motors Corp., Rochester, NY	1
General Motors Corp., Warren, MI	5
General Motors Overseas Operations, Detroit, MI	3
General Motors Technical Center, Warren, MI	2
General Tool Co., Cincinnati, OH	1
Geo Space Corp., Houston, TX	2
Gerdes Products Co., Brookville, OH	2
Gettys Manufacturing Co., Racine, WI	1
Giddings & Lewis-Bickford Machine Co., Kaukauna, WI	1
Giddings & Lewis Machine Tool Co., Fond Du Lac, WI	2
Gleason Works, Rochester, NY	2
Gold Metal Products Co., Cincinnati, OH	1
Goodman Equipment Corp., Chicago, IL	2

<u>Company</u>	<u>No. of Attendees</u>
Goodyear Aerospace Corp., Akron, OH	5
Gorham Tool Co., Detroit, MI	2
Gormac Products, Inc., Racine, WI	1
Gould Inc., Angola, IN	2
Gould Inc., McConnellsville, OH	2
Grapha Manufacturing Co., Hauppauge, NY	1
Gray, G. A., Co., Cincinnati, OH	9
Grumman Aerospace Corp. Bethpage, NY	1
H & C Tool Supply Co., Rochester, NY	1
Hall Industries Inc., Pittsburgh, PA	1
Hamilton Caster & Mfg. Co., Hamilton, OH	1
Hamilton Standard, Windsor Locks, CT	2
Hamilton Technology Inc., Lancaster, PA	1
Hamilton Tool Co., Cincinnati, OH	1
Harley Tool & Machine Inc., Bogota, NJ	1
Harris Corp., Champlain, NY	1
Harvey Hubbell, Inc., Huntington, WV	2
Heil Co. (The), Arab, AL	2
Hesston Corp., Hesston, KS	3
Hillard Corp. (The), Elmira, NY	2
Hobart Corp., Hillsboro, OH	3
Hobart Manufacturing Co., Troy, OH	1
Hoeganaes Corp., Riverton, NJ	1
Hollingsworth on Wheels, John D., Greenville, SC	2
Honeywell, Inc., Golden Valley, MN	1
Horix Manufacturing Co., McKees Rocks, PA	1
Houston Engineers Inc., Houston, TX	1
Howmet Corp., Whitehall, MI	2
Huber Corp., Marion, OH	2
Hughes Aircraft Co., Fullerton, CA	1
Huntington Alloys Inc., Huntington, WV	1
IBM Corp., Boulder, CO	4
IBM Corp., Endicott, NY	1
IBM Corp., Lexington, KY	2
IBM Corp., Research Triangle Park, NC	1
IIT Research Institute, Chicago, IL	1
ITT Harper, Morton Grove, IL	1
ITW, Inc. (Shakeproof Div.), Elgin, IL	2
Illinois Tool Works, Chicago, IL	1
Indian Springs Mfg. Co. Inc., Baldwinsville, NY	1
Industrial Nut Corp., Sandusky, OH	2
Industrial Tool Engineering Co., Detroit, MI	1
Ingersoll Manufacturing Consultants, Rockford, IL	1
Ingersoll-Rand Co., Athens, PA	2
Ingersoll-Rand Co., Mocksville, NC	2
Ingersoll-Rand Co., Painted Post, NY	5
Ingersoll-Rand Co., Phillipsburg, NJ	2
Institute of Metal Cutting, Krakow, Poland	1
International Harvester Co., Canton, IL	10

<u>Company</u>	<u>No. of Attendees</u>
International Harvester Co., East Moline, IL	1
International Harvester Co., Ft. Wayne, IN	5
International Harvester Co., Libertyville, IL	2
International Harvester Co., San Diego, CA	2
International Nickel Co., Huntington, WV	4
Interpace Corp. (Lapp Insulator Div.), LeRoy, NY	2
Iowa Industrial Hydraulics, Pocahontas, IA	1
Jeffrey Mfg. Co., Columbus, OH	4
Jeffrey Mfg. Co., Belton, SC	1
Jeffrey Mining Machinery, Columbus, OH	2
Jet Products, Inc., Braintree, MA	1
Jordan Valve, Cincinnati, OH	2
Joslyn Stainless Steel, Ft. Wayne, IN	3
KDI Precision Products, Inc., Cincinnati, OH	1
K-G Industries Inc., Rosemont, IL	2
Kearney & Trecker Corp., Milwaukee, WI	2
Kelsey-Hayes, Springfield, OH	2
Kentucky, University of, Lexington, KY	1
Kewaunee Engineering Corp., Kewaunee, WI	2
Kingsbury Machine Tool Corp., Keene, NH	2
Kinsey, E.A., Co. (The), Cincinnati, OH	1
Klima, F. J., Inc., Virginia, MN	2
Koehring Co. (Speedstar Div.), Enid, OK	2
Koehring Co. (HPM Div.), Mt. Gilead, OH	4
Kunkle Valve Co., Ft. Wayne, IN	2
Kyocera International, San Diego, CA	1
LTV Aerospace Corp., Warren, MI	2
LaBour Pump Co. (The), Elkhart, IN	4
Ladish Co., Cudahy, WI	1
Lake Engineering Co., Long Lake, MN	1
Lamson Products Co., Seattle, WA	2
Lawrence Livermore Labs, Livermore, CA	5
LeBlond Inc., Cincinnati, OH	2
Ledex, Inc., Vandalia, OH	3
Lenape Forge Div.-Gulf + Western, West Chester, PA	3
Liberty Screw Machine Products, Inc., Chicago, IL	1
Lockheed-Georgia Co., Marietta, GA	4
Lockheed Missiles & Space Co., Inc., Sunnyvale, CA	2
Logansport Machine Co. Inc., Logansport, IN	1
Lord Corp. (Kinematics Div.), Erie, PA	2
Lucas Machine, Cleveland, OH	2
Macon Machine Inc., Macon, GA	1
Madison Industries, Providence, RI	1
Madison-Kipp Corp., Madison, WI	2
Manufacturing Data Systems Inc., Ann Arbor, MI	1
Markem Corp., Keene, NH	2
Marsh Stencil Machine Co., Belleville, IL	1

<u>Company</u>	<u>No. of Attendees</u>
Martin Marietta Corp., Baltimore, MD	2
Martin Marietta Corp., Orlando, FL	2
Mate Punch & Die Co., Anoka, MN	2
McCrosky Tool Corp., Meadville, PA	2
McDonald, A.Y., Manufacturing, Dubuque, IA	2
McDonnell Douglas Corp., Grand Rapids, MI	2
McDonnell Douglas Corp., St. Louis, MO	4
McGraw-Edison Co., Cannonsburg, PA	2
M'Dionics Inc., Chicago, IL	1
Mechanical Mfg. Inc., Farmington, MI	4
Megadiamond Industries, New York, NY	9
Mercury Marine, Fond Du Lac, WI	1
Merkle Korff Gear Co., Franklin Park, IL	1
Mesta Machine Co., Pittsburgh, PA	1
Metalmasters, Inc. Lafayette, IN	1
Midland-Ross Corp., Owosso, MI	1
Mississippi State University, Mississippi State, MS	1
Missouri-Columbia, University of, Columbia, MO	1
Modernair Corp., Waterloo, IN	1
Moog Automotive Inc., St. Louis, MO	3
Moog, Inc., Buffalo, NY	1
Moog, Inc., East Aurora, NY	1
Mosler Safe, Hamilton, OH	2
Motch & Merryweather Machinery Co., Cleveland, OH	1
Mouck Machine Shop, Sandy Lake, PA	1
Muskegon Piston Ring Co., Schofield, WI	2
NASA-Lewis Research Center, Cleveland, OH	1
NIBCO, Inc., Blytheville, AR	3
NIBCO, Inc., Elkhart, IN	4
NKR Precision Mfg. Co. Inc., Harriman, NY	1
NRM Corp., Columbiana, OH	2
Namco Controls, Jefferson, OH	3
National Bureau of Standards, Washington, DC	1
National Castings, Sharon, PA	1
National Radio Astronomy Observatory, Green Bank, WV	2
National Supply Co., Div.-Armco Steel Corp., Houston, TX	1
*Naval Avionics Facility, Indianapolis, IN	5
*Naval Research Laboratory, Washington, DC	2
New England Carbide Tool Co., Peabody, MA	1
New York Blower Co., LaPorte, IN	1
*Newark Air Force Station, Newark, OH	2
Newcomer Products, Inc., Latrobe, PA	2
Niagara Machine & Tool Works, Buffalo, NY	2
Nichols, W.H., Co., Waltham, MA	1
Niles Precision Co., Niles, MI	2
Noonan Machine Co., Inc. (Stanley H. Holmes Co.), Franklin Park, IL	2
Nooter Corp., St. Louis, MO	2

*Department of Defense

<u>Company</u>	<u>No. of Attendees</u>
Nordson Corp., Amherst, OH	2
Norris Industries, Los Angeles, CA	1
North American Clutch Corp., Milwaukee, WI	1
North American Products Co., Jasper, IN	1
North American Products Co., Lebanon, PA	1
Northrop Corp., Hawthorne, CA	1
Northrop Corp., Norwood, MA	1
Norton Co., Worcester, MA	2
ORTEC, Inc., Oak Ridge, TN	1
Ohio Brass Co. (The), Mansfield, OH	3
Ohio Nuclear Co., Solon, OH	2
Olin Corp., New Haven, CT	6
Olofsson Corp., Lansing, MI	3
Omark Industries (KMS Div.), Moorestown, NJ	1
Otis Engineering Corp., Dallas, TX	1
Parker-Hannifin Corp., Elyria, OH	1
Parker-Hannifin Corp., Grantsburg, WI	1
Parker-Hannifin Corp., Metamora, OH	2
Perfecto Tool & Engineering Co., Inc., Anderson, IN	1
*Philadelphia Naval Shipyard, Philadelphia, PA	2
*Picatinny Arsenal, Dover, NJ	1
Pine Plating Co. Inc., Pine Island, MN	1
Pitney Bowes, Stamford, CT	2
Plymouth Foundry, Inc., Plymouth, IN	1
Porcelain Steel Bldgs. Co., Columbus, OH	1
Porter, H.K., Inc., Somerville, MA	1
Porter Precision Products Co., Cincinnati, OH	2
Pratt & Whitney Aircraft, West Palm Beach, FL	1
Preston Engravers, Inc., Windsor, CT	1
Procter & Gamble, Cincinnati, OH	4
Pyromet Industries, Inc., Muncie, IN	1
Pyronics Inc., Cleveland, OH	1
R. B. Machine Shop Inc., Avenel, NJ	1
RCA Components, El Paso, TX	3
Ransburg Corp., Indianapolis, IN	2
*Red River Army Depot, Texarkana, TX	1
Reece Corp. (The), Waltham, MA	4
RegO Co., Chicago, IL	2
Reliance Electric Co., (Dodge Mfg. Div.), Mishawaka, IN	1
Remington Arms Co., Inc., Ilion, NY	1
Remmele Engineering Inc., St. Paul, MN	2
Republic Steel Corp., Canton, OH	1
Republic Steel Corp., Youngstown, OH	2
Resistance Welder Corp., Bay City, MI	1
Reuland Electric Co., City of Industry, CA	4
Rexnord Inc., Downers Grove, IL	1
Reynolds Metals Co., Bauxite, AR	2
Reynolds Metals Co., Corpus Christi, TX	1
Reynolds, R. J., Tobacco Co., Winston-Salem, NC	5

*Department of Defense

<u>Company</u>	<u>No. of Attendees</u>
Richards Industries, Inc., Cincinnati, OH	2
Richards, J. A., Co., Kalamazoo, MI	1
Robbins & Myers, Inc., Springfield, OH	2
*Rock Island Arsenal, Rock Island, IL	1
Rock Valley College, Rockford, IL	1
Rockwell International, Allegan, MI	1
Rockwell International, Anaheim, CA	1
Rockwell International, Ashtabula, OH	8
Rockwell International, East Moline, IL	1
Rockwell International, Fairfield, CT	1
Rockwell International, Kenton, OH	4
Rockwell International, Los Angeles, CA	1
Rockwell International, Newark, OH	10
Rockwell International, Pittsburgh, PA	1
Rockwell International, Raleigh, NC	1
Rockwell International, Troy, MI	1
Rockwell International, Tupelo, MS	2
Rockwell International, Winchester, KY	4
Rollway Bearing Co., Syracuse, NY	1
Royer Foundry & Machine Co., Kingston, PA	3
Rucker/Atlas Bradford, Houston, TX	2
SKIL Corp., Chicago, IL	2
Saginaw Machine & Tool Co., Saginaw, MI	1
Sandia Laboratories, Albuquerque, NM	3
Sandy Hill Corp., Hudson Falls, NY	2
Sargent Industries, Odessa, TX	1
Schrader Automotive Products, Dickson, TN	1
Schwitzer Engineered Components, Indianapolis, IN	10
Scot Industries Inc., Milwaukee, WI	1
Sealed Power Corp., Rochester, IN	2
Setco Industries, Inc., Cincinnati, OH	3
Signode Corp., Florence, KY	5
Simplatrol Products-Formsprag Co., Webster, MA	1
Smith, A. O., Corp., Erie, PA	2
Smith Meter Systems, Erie, PA	1
Snyder Corp., Detroit, MI	2
South Bend Controls, South Bend, IN	2
Southwest Research Institute, San Antonio, TX	2
Spaulding Fibre Co., Inc., Gonic, NH	1
Sperry Flight Systems, Phoenix, AZ	1
Sperry Vickers, Omaha, NB	1
Sperry Vickers, Salem, OH	1
Sprout-Waldron-Koppers, Muncy, PA	1
Square D Co., Oxford, OH	1
Stallman Gear, Columbus, OH	1
Stamets, Wm. K., Co., Columbiana, OH	1
Standard Oil Co., Louisville, KY	1
Standard Steel, Burnham, PA	2
Stanford Linear Accelerator Center, Stanford, CA	1

*Department of Defense

<u>Company</u>	<u>No. of Attendees</u>
Stark, Charles, Draper Labs., Cambridge, MA	3
Stedman Foundry & Machine Co., Inc., Aurora, IN	2
Steiger Tractor, Inc., Fargo, ND	1
Stewart Industries, Inc., Cincinnati, OH	3
Stewart Warner, Indianapolis, IN	1
Stinson Mfg. Co., San Antonio, TX	1
Stora Kopparberg Corp., Darien, CT	1
Storm-Vulcan, Inc., Dallas, TX	2
Sundstrand Corp. (Hydro-Transmissions Div.), Ames, IA	2
Sundstrand Corp. (Aviation Div.), Rockford, IL	3
Super-Cut, Inc., Chicago, IL	6
Superior Die Set Corp., Oak Creek, WI	2
Superior Tube Co., Norristown, PA	1
Sutton Engineering Co., Bellefonte, PA	1
T.C. Industries Inc., Crystal Lake, IL	1
T.D.M. Corp., Fletcher, NC	1
T.K. International, Inc., Tulsa, OK	1
TRW Inc., Cleveland, OH	3
TRW Inc., Dayton, OH	7
TRW Inc., Redondo Beach, CA	1
TRW Mission Mfg. Co., Houston, TX	3
TRW Reda Pump Co., Bartlesville, OK	2
TRW-Wendt Sonis, Rogers, AR	3
Taylor Forge Div.-Gulf + Western, Cicero, IL	2
Tek-O-Motive, Inc., La Moille, IL	2
Teledyne CAE, Toledo, OH	2
Teledyne Continental Motors, Mobile, AL	2
Teledyne Landis Machine Co., Waynesboro, PA	2
Teledyne Precision-Cincinnati, Cincinnati, OH	2
Therm Inc., Ithaca, NY	1
Thermo Electron, Woburn, MA	2
Thiry Machine Co., Inc., Detroit, MI	1
Thrush Products, Inc., Peru, IN	4
Tomkins-Johnson Co., Jackson, MI	2
Tompkins-Cortland Community College, Dryden, NY	1
Tool Crib, Inc. (The), Knoxville, TN	4
Tool Steel Gear & Pinion Co. (The), Cincinnati, OH	20
Townsend Co., Plymouth, MI	2
Trade Tool Corp., Youngstown, OH	1
Transtech, Sylvania, OH	1
Troyke Manufacturing Co., Cincinnati, OH	2
Tyson Bearing Co., Glasgow, KY	2
Tyson Bearing Co., Massillon, OH	2
*U.S. Army Tank Automotive Command, Warren, MI	4
U.S. Steel Corp., Garland, TX	1
*USAF, Wright-Patterson AFB, OH	3
Union Carbide Corp., Chicago, IL	1
Union Carbide Corp., Oak Ridge, TN	8

*Department of Defense

<u>Company</u>	<u>No. of Attendees</u>
Union Chain Co., Sandusky, OH	2
Union Pump Co., Battle Creek, MI	9
Upton Machine Products Inc., Painesville, OH	6
VRC Corp., Olmsted Falls, OH	1
Valeron Corp., Battle Creek, MI	4
Valeron Corp., Cincinnati, OH	1
Van Wood Mfg. Co. Inc., Cherry Hill, NJ	1
Varco, International, Orange, CA	1
Ventura Industries, Inc., Detroit, MI	1
Vogt, Henry, Machine Co., Louisville, KY	1
Vought Corp., Sterling Heights, MI	1
Vulcan Mfg. Co., Cincinnati, OH	1
Wade & Sons Inc., Independence, MO	2
Wallace & Tiernan, Belleville, NJ	1
Walworth Co., Greensburg, PA	1
Ward Machinery Co., Cockeysville, MD	1
Warnecke Electron Tubes Inc., Des Plaines, IL	2
Warner Electric Brake & Clutch Co., South Beloit, IL	4
Warner Gear Div., Muncie, IN	2
Warner & Swasey Co., Cleveland, OH	7
Washington Mould, Machine & Foundry Co., Washington, PA	3
Waupaca Foundry Inc., Waupaca, WI	1
Wayne Novelty Inc., Decatur, IN	1
Weatherhead Co., Antwerp, OH	4
Weatherhead Co., Syracuse, IN	1
Webster Manufacturing Co., Tiffin, OH	3
Wedler Brothers, Inc., Cleveland, OH	1
West Milton Precision Machining & Tool, Inc., Vandalia, OH	2
Western Gear Corp., Lynwood, CA	1
Western Gear Corp., Jamestown, ND	5
Westhoff Tool & Die Co., Inc., St. Louis, MO	5
Westinghouse Electric Corp., Baltimore, MD	1
Westinghouse Electric Corp., Charlotte, NC	2
Westinghouse Electric Corp., Cheswick, PA	1
Westinghouse Electric Corp., Hunt Valley, MD	1
Westinghouse Electric Corp., Madison, PA	1
Westinghouse Electric Corp., Orville, OH	1
Westinghouse Electric Corp., Sunnyvale, CA	10
Wheelabrator-Frye, Inc., Mishawaka, IN	1
Wilton Corp., Schiller Park, IL	1
Windsor Mfg. Co. (The), Windsor, CT	2
Worthington Compressors Inc., Buffalo, NY	1
Worthington Marine & Industry Products, Harrison, NJ	1
Worthington Pump Corp., Harrison, NJ	1
Wyman-Gordon Co., Worcester, MA	3
Wysong & Miles Co., Greensboro, NC	2
York Industries Inc., Emigsville, PA	1
Total -	1,188

TABLE 13-B.
ORGANIZATIONS WITH 4 OR MORE ATTENDEES
REPRESENTED AT MDC'S SEMINARS ON
"PRACTICAL MACHINING PRINCIPLES FOR SHOP APPLICATION"
(Spring 1974 - Fall 1976)*

<u>Company</u>	<u>No. of Attendees</u>	<u>Company</u>	<u>No. of Attendees</u>
ARO, Inc.	15	LaBour Pump Co.	4
Aeroquip Corp.	9	Lawrence Livermore Labs	5
AiResearch Mfg. Co.	4	Lockheed	6
Allis-Chalmers Corp.	29	Martin Marietta Corp.	4
Andrew Corp.	4	McDonnell Douglas Corp.	6
Babcock & Wilcox	22	Mechanical Mfg. Inc.	4
Bell Helicopter Co.	4	Megadiamond Industries	9
Bendix Corp.	4	Moog, Inc.	5
Chamberlain Mfg. Corp.	4	NIBCO, Inc.	7
Chemetron Corp.	6	Naval Avionics Facility	5
Chrysler Corp.	9	Olin Corp.	6
Cincinnati Inc.	5	Parker-Hannifin Corp.	4
Clark Equipment Co.	4	Procter & Gamble	4
Cummins Engine Co.	7	Reece Corp.	4
Cutler-Hammer, Inc.	5	Reuland Electric Co.	4
Dana Corp.	7	Reynolds, R.J., Tobacco Co.	5
Dearborn, Howard, Inc.	13	Rockwell International	36
Defense Contract Admin. Management Area	5	Schwitzer Engineered Components	10
Diamond Chain Co.	5	Signode Corp.	5
Dover Corp.	6	Sundstrand Corp.	5
Dresser Industries	5	Super-Cut, Inc.	6
Eaton Corp.	14	TRW	19
Electric Machinery Mfg. Co.	6	Teledyne	8
Elliott Corp.	4	Thrush Products, Inc.	4
FMC Corp.	5	Tool Crib, Inc. (The)	4
General Dynamics	5	Tool Steel Gear & Pinion (The)	20
General Electric Co.	18	Tyson Bearing Co.	4
General Motors Corp.	19	U.S. Army Tank Automotive Command	4
Goodyear Aerospace Corp.	5	Union Carbide Corp.	9
Gould Inc.	4	Union Pump Co.	9
Gray, G.A., Co.	9	Upson Machine Products Inc.	6
Hobart Corp.	4	Valeron Corp.	5
IBM Corp.	8	Warner Electric Brake & Clutch Co.	4
Ingersoll-Rand Co.	11	Warner & Swasey Co.	7
International Harvester Co.	20	Weatherhead Co.	5
International Nickel Co.	4	Western Gear Corp.	6
Jeffrey Mfg. Co.	5	Westhoff Tool & Die Co.	5
Koehring Co.	6	Westinghouse Electric Corp.	17

*Includes one seminar planned during this contract period that was held in January 1977 to handle overflow from the fall series.

TABLE 14. - CONTRIBUTIONS TO LITERATURE BY FULL- AND PART-TIME PERSONNEL
(August 1975 - December 1976)

Variation in surface stress due to metal removal.

P. S. Prevey, M. Field, *Annals of the CIRP*, Vol. 24/1, 1975, pp. 497-501.

Implications for data banks and information centers, Part I -(machining).

A. F. Ackenhausen, Paper No. EM75-373, Society of Manufacturing Engineers, Dearborn, MI, 1975.

Economic generation of tool life data using the R-T characteristic curve.

M. Y. Friedman, V. A. Tipnis, M. Field, *Proceedings of the Machine Tool Design and Research Conference*, London: Macmillan, 1975, pp. 537-541.

Influence of material and its metallurgical state on surface integrity.

G. Bellows, M. Field, J. B. Kohls, *Influence of Metallurgy on Machinability, Proceedings from an International Symposium*, Metals Park, OH: American Society for Metals, 1975, pp. 272-295.

The influence of non-metallic inclusions on the machinability of free-machining steels.

R. A. Joseph, V. A. Tipnis, *Influence of Metallurgy on Machinability, Proceedings from an International Symposium*, Metals, Park, OH: American Society for Metals, 1975, pp. 55-72.

Machining characteristics of difficult to machine materials.

N. Zlatin, J. D. Christopher, *Influence of Metallurgy on Machinability, Proceedings from an International Symposium*, Metals Park, OH: American Society for Metals, 1975, pp. 296-307.

Testing for machinability.

V. A. Tipnis, R. A. Joseph, *Influence of Metallurgy on Machinability, Proceedings from an International Symposium*, Metals Park, OH: American Society for Metals, 1975, pp. 11-30.

Metallurgical alterations in surfaces produced by metal removal operations.

M. Field, *Proceedings of the 4th Colloquium on Surface Problems*, Karl-Marx-Stadt Technical University, East Germany, 1976, Paper No. 36.

Surface integrity: An emerging criterion for quality assurance.

W. P. Koster, Paper No. IQ76-926, Society of Manufacturing Engineers, Dearborn, MI, 1976.

Development of mathematical models for adaptive control systems.

V. A. Tipnis, *NC/CAM - The New Industrial Revolution: Proceedings of the Thirteenth Annual Meeting and Technical Conference*, Glenview, IL: Numerical Control Society, Inc., 1976, pp. 149-156.

Group technology and numerical control machining.

M. F. DeVries, V. A. Tipnis, *NC/CAM - The New Industrial Revolution: Proceedings of the Thirteenth Annual Meeting and Technical Conference*, Glenview, IL: Numerical Control Society, Inc., 1976, pp. 371-381.

Practical cost and production time analysis aids for NC programmers.

S. C. Buescher, S. A. Vogel, V. A. Tipnis, *NC/CAM - The New Industrial Revolution: Proceedings of the Thirteenth Annual Meeting and Technical Conference*, Glenview, IL: Numerical Control Society, Inc., 1976, pp. 409-419.

Machining: A process checklist.

G. Bellows, Publication No. MDC 76-100, Cincinnati, OH: Machinability Data Center, Metcut Research Associates Inc., 1976.

Nontraditional machining: Where does it stand?

G. Bellows, *Modern Machine Shop*, Part I - Chemical Machining, Vol. 48 (April 1976), pp. 84-93; Part II - Electrical Machining, Vol. 48 (May 1976), pp. 103-115; Part III - Mechanical Machining, Vol. 49 (June 1976), pp. 109-116; Part IV - Thermal Machining, Vol. 49 (July 1976), pp. 79-90.

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